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DAMAGE TO SUGAR CANE IN LOUISIANA
BY THE SUGAR-CANE BORER.

BY

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Agent and Expert.



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United States Department of Agriculture,

BUREAU OF ENTOMOLOGY.

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DAMAGE TO SUGAR CANE IN LOUISIANA BY THE SUGAR-CANE BORER.

(*Diatraea saccharalis* Fab.)

By T. C. BARBER,

Agent and Expert.

(The work upon which this circular is based was conducted in direct cooperation with the Louisiana Sugar Experiment Station, Audubon Park, New Orleans, La.).

INTRODUCTION.

The sugar-cane borer (*Diatraea saccharalis*¹ Fab.) has been the most serious insect enemy of sugar cane with which the Louisiana planter has had to contend for many years. In a bulletin of the Louisiana Experiment Station² Dr. W. C. Stubbs gave an exhaustive account of the probable source of introduction in 1856, in cane imported from South America. He also referred to numerous cases of severe infestation which occurred at various times previous to 1880. In 1880³ Dr. L. O. Howard conducted investigations on this insect, and mentioned that the first specimen was sent in to the Department of Agriculture at Washington in 1878. He also cites several instances of previous severe infestation, one occurring as far back as 1857 "along the Lower Mississippi." In 1891 Prof. H. A. Morgan published a bulletin on the "Sugar-Cane Borer and its Parasite,"⁴ in response to a demand for information following a severe outbreak of the cane borer in 1890. Another severe outbreak in Louisiana in 1900 was followed by the publication of Bulletin 70, referred to above, in which Dr. Stubbs gave the first statement as to the actual amount of financial damage caused to sugar cane by the cane borer (p. 889). In the case of one factory, where fair comparison was obtainable between cane

¹ The form which attacks the stalks of corn, previously confused with *Diatraea saccharalis*, has been found by Dr. H. G. Dyar of this bureau to belong to a new species and has been described by him under the name *Diatraea zeacolella*. (See Entomological News, vol. 22, no. 5, p. 203, May, 1911.)

² Cane Borer (*Diatraea saccharalis*). Bul. 70, 2d ser., La. Exp. Sta., Baton Rouge, La., 1902, W. C. Stubbs and H. A. Morgan.

³ Rept. Dept. Agr., 1880, p. 240.

⁴ Bul. 9, 2d ser., La. Exp. Sta., 1891.

uninfested and infested for a number of consecutive years, he estimated the damage at \$136,335 for three years on plant cane alone, or \$45,445 per year, nearly \$1,000 per day during the grinding season for this one factory. When it is considered that most of the area devoted to cane growing in Louisiana is infested with the borer, it can easily be appreciated from the above figures that the total financial loss must be enormous.

One of the special lines of work planned by Mr. D. L. Van Dine, when the laboratory for the investigation of sugar-cane insects was established by this Bureau in 1910, was the determination of the various classes of injury caused by the cane borer. Observations and experiments were conducted by the writer in 1910. It was discovered that the borer is responsible for much more injury than is apparent at first sight. Its harmful work begins with the destruction of eyes of seed cane, reducing the stand during the following year; continues through the growing season of the cane by stunting its growth, and causing damage from windstorms, owing to the weakening of the stalk due to the burrows and girdles; and ends by causing a much lower percentage of juice, which is again of a much poorer quality in infested canes than in uninfested canes. The last is an important form of injury, which appears to have been overlooked by investigators and planters.

Moreover, the holes made by the cane borers are the chief means of entrance to the stalk afforded the various fungous diseases of the sugar cane. The tonnage yield per acre is reduced by borers, and the average weight of canes otherwise similar in appearance is found to be reduced by borer infestation.

These points will be explained in detail under the following headings: Injury to seed cane; injury to growing cane; injury to mature cane and juice.

INJURY TO SEED CANE BY THE SUGAR-CANE BORER.

The buds of cane are favorite places for the attack of the young borers while the stalk is growing, due to the softness of the tissue compared to the woodiness of the rind of the cane stalk in other locations. The young larvæ of the sugar-cane borer will enter the buds or eyes of the cane, and in nearly every case the attack will result in the destruction of the bud. Frequently canes will be seen in which more than 50 per cent of the buds have been destroyed by the borer. Of course, many borers enter the stalk at other places, around and between the joints, as an average cane will contain only from 6 to 15 joints, while canes will often be found with from 6 to 10 borer holes in a single joint. In nearly every case of severe infesta-

tion, however, it will be found that a considerable percentage of the eyes has been destroyed.

In order to secure definite data as to the extent of this injury, a number of borer-infested canes were picked up at random from a pile of cane on a property which probably represents typical conditions in Louisiana. The eyes were then counted until 100 were reached, and the number of injured eyes noted. No attention was paid to the amount of borer infestation in each stalk, beyond ascertaining that at least one borer hole was visible. In the first 100 eyes counted 23 had been destroyed by the borers. On repeating the above experiment it was found that 18 eyes had been destroyed in the second lot of 100, making a total of 41 eyes destroyed out of a total of 200, or 20.5 per cent. The infestation of the plat from which this cane was secured was approximately determined at 53 per cent, which would indicate that over 10 per cent of the entire number of eyes in the plat had been destroyed by borers.

The effect of this is to reduce the stand of cane the following year by reducing the number of viable eyes in the planted cane. The borers also damage the seed cane to a certain extent by absorbing a considerable amount of the sap or juice which nature intended to be used to nourish the buds when they commence to grow, but this injury probably does not assume much economic importance.

INJURY TO GROWING CANE BY THE SUGAR-CANE BORER.

When the cane sprouts in the spring a certain amount of damage is done to it by the larvæ of the first brood, which bore into the hearts of the young and tender shoots. Very frequently the terminal leaves turn yellow, and on being pulled come out of the whorl of the plant bodily. Examination reveals the fact that they have been almost cut off in the heart of the plant, and often the small worm is found in the excavation. It is likely that this source of injury causes considerable damage to the stand of cane, although no experiments have yet been made to determine the percentage of injury.

Borers are also responsible for very considerable damage by windstorms. After a severe windstorm in the fall the observer can notice two effects upon sugar cane. In some cases the cane will be blown prostrate, being left lying nearly horizontally upon the ground. In other cases many of the stalks are broken by the wind, sometimes close to the ground, sometimes in the center or near the top of the cane. In the case of cane which has been blown over, it will often become more or less upright, and in any event it will continue growth. The greatest injury produced upon it is crooked and bent stalks, which are troublesome to harvest.

In the event of the stalks being broken, however, the damage is very different. In this case the growth of the cane stops, and the buds on the top joints below the fracture sprout and commence to grow. The process of growth draws upon the supply of sugar stored in the parent cane, so that the cane is not only prevented from reaching its fullest maturity, but also stands a very good chance of losing a percentage of the sugar already stored up in the stalk.

A close examination of a cane field after a heavy wind will show that to borer injury is directly due the great majority of broken stalks. A cane will seldom break in a wind unless the stem has been physically injured, and examination of broken stalks nearly always shows that the breaks occur at a borer girdle or a large burrow near the surface of the cane. The burrows and tunnels in the stalks frequently concentrate upon a certain joint, with the result that it will be materially weakened and will snap off at the slightest provocation. Many canes are literally girdled by borers, a tunnel being made just inside the rind completely around the cane and only the center is left to hold up the top.

To a large extent, also, borers are directly responsible for the spread of fungous diseases in sugar cane. In order that the fungus may enter a plant it is nearly always necessary for the spores to settle on an excision or wound in the rind of the cane. These openings are furnished in great numbers by the borer holes. Dr. C. W. Edgerton,¹ in "Some Sugar-Cane Diseases," advises that all "seed" cane showing *external evidence of borer injury* be thrown out, as a preventive of fungous diseases. L. Lewton-Brain², in considering the rind disease (*Melanconium sacchari*), says:

Whenever it is possible to trace the discoloration to its starting point, this will always be found to be a wound of some sort. The wound may be a borer hole, a leaf-hopper puncture, or a wound made in stripping, the borer wounds being perhaps most favorable to the fungus, especially in the older parts of the stalk.

INJURY TO MATURE CANE BY THE SUGAR-CANE BORER.

AMOUNT OF INFESTATION.

In order to determine the extent of borer infestation an elaborate examination of canes was made during the fall of 1910. The general practice was to examine 100 canes across each end of a plat and 100 canes across the middle. These hundreds were divided into 4 groups of 25 canes each at different points in the row. This plan was modified in varying degrees as circumstances made it necessary or advisable. In all, the infestation was approximately determined in 9 plats planted to cane. Of these 9 plats 3 were in stubble and 6

¹ Bul. 120, La. Exp. Sta., p. 12, 1910.

² Bul. 7, Hawaii Sugar Planters' Association Experiment Station, 1907.

in plant cane. The least injury to a cane by a borer served to throw it into the infested column. The general results are shown in Table I:

TABLE I.—*Infestation by the sugar-cane borer.*

Class of cane.	Number of canes examined.	Borer free.	Borer infested.	Percentage of infestation.
Plant cane.....	1,900	603	1,297	68.26
Stubble cane.....	1,100	341	759	69
All canes.....	3,000	944	2,056	68.53

In addition to the canes referred to in the table, two other large lots were removed from the plats for other purposes and examined for borer infestation. One hundred canes were taken from a plant-cane plat for determining the comparative weights of infested and uninfested canes. These canes were infested to the extent of 72 per cent. From a stubble plat 734 canes were removed for determining the effect of the borer upon the sugar content of the cane. Of these canes 393, or 53.54 per cent, were infested. Both of these experiments are described in detail elsewhere. Adding these counts to the previous number we have a total of 3,834 canes, of which 1,313 were borer free and 2,521, or 65.75 per cent, were infested by the borer.

INFESTATION OF TOPS.

In five instances the same number of tops as of canes were examined and showed a distinct correlation between the infestation of the two parts of the stalk, the infestation in the tops increasing to correspond with the increase in the infestation of the canes. This is very suggestive as to the value of clean burning of the trash after removing cane from a severely infested field. The data on this point are given in Table II:

TABLE II.—*Infestation of tops by the sugar-cane borer.*

Varieties.	Per cent infestation in canes.	Per cent infestation in tops.
Purple.....	59	5
D. 95.....	79	7
D. 74.....	81	17
Striped.....	89	18
Purple.....	95	31

CENTER OF HEAVIEST INFESTATION.

That it is the tendency of the borers to seek the middle of the plat is suggested by the fact that in 4 cases the highest percentage of infestation was found in that portion, while in only 1 case was the

lowest infestation found in the middle of the plat. On the other hand, in 6 cases out of 7, where comparison could be made, the lowest infestation was found at the ends of the plats. It may be said in general that the highest infestation will be found in the most luxuriant cane.

CHARACTER OF INFESTATION IN PLANT CANE AND STUBBLE CANE.

In fall plant cane the majority of the infestation is in the upper half of the cane, while in stubble cane the infestation is more noticeable near the ground, although the whole stalk is more or less infested. This may be due to the earlier sprouting of the stubble cane in the spring, thus causing it to be liable to attack from the early broods of borers; and also a certain number of borers may hibernate in the stubble, thus being present in the spring to infest the early sprouting cane. On the other hand, fall plant cane does not appear above the ground as early in the spring as stubble, and as the adults that appear in the seed cane are too delicate to dig through the soil to the surface they perish underground. A field of fall plant cane may be regarded as borer free in the spring, and will become infested during the following summer from outside sources, probably to a degree depending upon the severity of infestation in the surrounding territory.

The fact that the most evident borer injury occurs in the lower half of the stalk in stubble cane makes the damage greater than in plant cane for several reasons. The first is that the actual mechanical injury by the borer is in the lower joints, which are more mature and have the greater sugar content. Again, the presence of the borer burrows and tunnels in the lower joints affects the flow of sap to the top of the cane, thus interfering, more or less, with the growth of the whole cane. Also, the joints near the base of the plant tend to become hard and woody following borer attack, thus increasing the percentage of fiber and decreasing the percentage of juice. Incidentally the latter point increases the difficulty of grinding, as was called to the attention of the writer by a sugar-house manager attributing the breaking of some machinery to the crushing of heavily infested sugar cane.

EFFECT OF INFESTATION UPON THE WEIGHT OF CANE.

In order to find out the effect of borer infestation upon the weight of cane, 100 stalks were picked out and carefully averaged in size. All were cut off the same length. No attention was paid to borer infestation in selecting the canes, and the opinions of several gentlemen were consulted, all canes larger or smaller than the average being thrown out and replaced by others until on examination it was impossible to select canes larger or smaller than the others.

These canes were then examined for borer injury, 72 being found infested and 28 borer-free. The smallest damage to a cane by a borer was sufficient to place it among the infested canes. The canes were then weighed, with the results shown in Table III:

TABLE III.—*Effect of borer attack upon weight of cane.*

Class of canes.	Number of canes.	Weight of canes.	Average weight per cane.	Number of canes per ton.	Loss in weight per ton due to borer.	Loss in weight due to borer.
		<i>Pounds.</i>	<i>Pounds.</i>		<i>Pounds.</i>	<i>Per cent.</i>
Borer-free.....	28	103	3.68	543.5	.....	.....
Borer-infested.....	72	255	3.54	565.0	76.0	3.8

For further results a wagonload of cane was taken to the sugar-house, and was there separated into two lots, infested and uninfested. Of the 734 canes, 393, or 53.54 per cent, were infested. The least injury by borers placed a cane in the infested lot. Each lot of cane was then weighed separately on platform scales. The 393 infested canes weighed 694 pounds, an average of 1.76 pounds per cane, while the 341 borer-free canes weighed 626 pounds, or an average of 1.84 pounds per cane.

TABLE IV.—*Loss of weight due to borer attack.*

Canes.	Number of canes.	Weight of canes.	Average weight per cane.	Number of canes per ton.	Loss in weight per ton due to borer.	Loss in weight due to borer.
		<i>Pounds.</i>	<i>Pounds.</i>		<i>Pounds.</i>	<i>Per cent.</i>
Borer-free.....	341	626	1.84	1,087	.....	.....
Borer-infested.....	393	694	1.76	1,136	86.24	4.31

On the basis of Table IV the difference in yield between borer-free and borer-infested cane fields would amount to a loss of about 1 ton of cane per acre when the borer-free cane gives a yield of 25 tons per acre.

EFFECT OF BORER INFESTATION UPON CANE JUICE.

The following series of experiments was carried out to ascertain just what damage the cane borer inflicts upon the cane juice, in addition to the physical damage to the cane plant:

Experiment 1.—Six stalks of D. 74 cane were selected, three being heavily infested by the borer and three being borer-free. The stalks were cut into four samples, as follows:

- (1) $3\frac{1}{2}$ bottom joints, borer-free canes.
- (2) $3\frac{1}{2}$ bottom joints, borer-infested canes.
- (3) $3\frac{1}{2}$ top joints, borer-free canes.
- (4) $3\frac{1}{2}$ top joints, borer-infested canes.

Samples 1 and 3 and samples 2 and 4 were thus from the same canes. Each sample was carefully weighed, run through a 3-roller hand mill, and the weight of juice from each sample recorded. The juice was then analyzed, the latter operation being kindly performed by Mr. W. G. Taggart, chemist at the sugar experiment station.

Sample 2 (bottom joints) showed, compared with sample 1, losses due to the borer of 4.59 per cent of juice, 2.6 per cent total solids, 4 per cent sucrose, and 12 per cent purity, and an increase of solids not sugar of 0.8 per cent.

Sample 4 (top joints), compared with sample 3, showed losses of 7.27 per cent of juice, 4.2 per cent total solids, 4.9 per cent sucrose, and 13.7 per cent purity, and an increase of solids not sugar of 0.8 per cent. It can thus be seen that the borer not only reduced the juice quantitatively but qualitatively as well and to a more marked degree.

Placing these figures on a basis of 1 ton of cane to the sample, we have the following results: Sample 2 showed losses of 91.8 pounds of juice, 35.2 pounds of total solids, 59 pounds of sucrose, and a percentage loss of sucrose of 34.04 per cent. The increase in solids not sugar was 8 pounds per ton of cane. Sample 4 showed losses of 145.4 pounds of juice, 68.6 pounds total solids, 70.9 pounds sucrose, and 46.43 per cent sucrose actual loss, with an increase of solids not sugar of 5.4 pounds per ton. The average production of the total borer-free cane (samples 1 and 3) was 163 pounds sucrose per ton of cane and of the total infested cane (samples 2 and 4) 98.1 pounds sucrose per ton of cane. This gives an average loss of 64.9 pounds, or 39.81 per cent, of sucrose per ton of cane due to the borer. The results of this experiment are given in tabular form in Table V.

TABLE V.—*Analysis of sugar cane (D. 74) to determine effect on sugar content of the borer injury to sugar cane.*

No. of sample.	Nature of sample.	Weight of cane.	Weight of juice.	Per cent of juice.	Loss of juice due to borer.	Total solids in juice.	Loss in total solids due to borer.	Glucose in juice.	Glucose ratio.	Solids not sugar in juice.	Sucrose in juice.	Loss in sucrose due to borer.	Purity.	Loss in purity due to borer.
		Grams.	Grams.	P.ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1	3½ bottom joints borer-free canes.....	1,512	419	62.33	....	16.6	.....	1.3	9.3	1.4	13.9	.....	83.7	.....
2	3½ bottom joints borer-infested canes.....	1,008	582	57.74	4.59	14.0	2.6	1.9	19.2	2.2	9.9	4.0	71.7	12.0
3	3½ top joints borer-free canes.....	1,282	783	61.08	....	16.1	.....	1.4	12.0	2.2	12.5	.....	78.6	.....
4	3½ top joints borer-infested canes.....	985	530	53.81	7.27	11.9	4.2	1.3	17.1	3.0	7.6	4.9	64.9	13.7

NOTE.—Samples 1 and 3, 2 and 4, were from the same canes. Each sample consisted of portions of three canes. Analysis made Nov. 10, 1910.

TABLE V.—*Analysis of sugar cane (D. 74) to determine effect on sugar content of the borer injury to sugar cane—Continued.*

RESULTS OF ABOVE ANALYSIS FIGURED ON A BASIS OF 1 TON OF CANE TO THE SAMPLE.

No. of sample.	Nature of sample.	Weight of cane.	Weight of juice.	Loss of juice per ton due to borer.	Total solids per ton.	Loss of total solids per ton due to borer.	Glucose per ton.	Increase glucose due to borer.	Solids not sugar per ton.	Increase solids not sugar due to borer.	Sucrose per ton.	Loss in sucrose due to borer.	Loss in sucrose due to borer.
1	3½ bottom joints borer-free canes.....	Lbs. 2,000	Lbs. 1,246.6	Lbs.	Lbs. 206.9	Lbs.	Lbs. 16.2	Lbs.	Lbs. 17.4	Lbs.	Lbs. 173.3	Lbs.	P. ct.
2	3½ bottom joints borer-infested canes.....	2,000	1,154.8	91.8	171.7	35.2	21.9	5.7	25.4	8.0	114.3	59.0	34.04
3	3½ top joints borer-free canes.....	2,000	1,221.6	....	196.7	....	17.1	....	26.9	....	152.7	....	....
4	3½ top joints borer-infested canes.....	2,000	1,076.2	145.4	128.1	68.6	14.0	3.1	32.3	5.4	81.8	70.9	46.43
Average weight of sucrose per ton:													
Samples 1 and 3.....											163.0		
Samples 2 and 4.....											98.1	64.9	39.81

Experiment 2.—The remarkable figures obtained in *Experiment 1* showed the advisability of conducting a further experiment upon a larger scale in order to obtain more conclusive results. For this experiment 30 canes were selected at random from D. 74 cane. Of these 10 were borer-free, 10 were medium infested (1 to 3 joints per cane showing borer injury), and 10 were heavily infested (5 or more infested joints per cane). It should be remarked that the infestation in the heavily infested canes was not so heavy as was the infestation of samples 2 and 4 of the first experiment, in which every joint was infested. Each sample of 10 canes was separately weighed, run through the hand mill, and analyzed exactly as had been done with the samples of the first experiment. The analyses were again made by Mr. W. G. Taggart. The results obtained fully upheld those of the first experiment.

Sample 2 (medium infested) showed losses due to the borer of 0.3 per cent juice, 1 per cent total solids, 1.2 per cent sucrose, 2.2 per cent purity, and an increase of solids not sugar of 0.1 per cent. Sample 3 (heavily infested) showed losses of 2.3 per cent juice, 3.4 per cent total solids, 4.6 per cent sucrose, 12.7 per cent purity, and an increase of 0.7 per cent solids not sugar.

Reduced to a basis of 1 ton of cane to the sample, the results were as follows: Sample 2 (medium infested) showed losses per ton of cane of 6 pounds juice, 13.19 pounds total solids, 15.46 pounds sucrose, 8.78 per cent actual loss of sucrose, and an increase in solids not sugar of 1.15 pounds. Sample 3 (heavily infested) showed losses per ton of cane of 46 pounds juice, 47.85 pounds total solids,

60.72 pounds sucrose, and an increase in solids not sugar of 7.73 pounds.

Comparing the percentage loss of sucrose in the heavily infested cane of this experiment, 34.51 per cent, with the average loss of samples 2 and 4 in the first experiment, 39.81 per cent, and considering that the latter cane was more thoroughly infested than the former, it will be seen that the results of the first experiment were not exaggerated to any great degree by reason of the smallness of the samples. The complete results of this experiment are shown in Table VI.

TABLE VI.—*Analysis of sugar cane (D. 74) to determine effect on sugar content of the borer injury to cane.*

No. of sample.	Nature of sample.	Weight of cane.	Weight of juice.	Per cent of juice.	Loss of juice due to borer.	Total solids in juice.	Loss in total solids due to borer.	Glucose in juice.	Solids not sugar in juice.	Glucose ratio.	Sucrose in juice.	Loss in sucrose due to borer.	Purity.	Loss in purity due to borer.
		Gms.	Gms.		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.		P. ct.	P. ct.		
1	Borer-free.....	9,990	6,108	61.1	.....	17.1	.....	1.6	1.1	11.1	14.4	.....	84.2	.....
2	Medium infested.....	11,081	6,735	60.8	0.3	16.1	1.0	1.7	1.2	12.9	13.2	1.2	82.0	2.2
3	Heavily infested.....	8,824	5,190	58.8	2.3	13.7	3.4	2.1	1.8	21.4	9.8	4.6	71.5	12.7

NOTE.—Each sample consisted of 10 canes. Each of the medium-infested canes contained from one to three infested joints, and each of the heavily infested canes five or more infested joints. Analysis made Nov. 12, 1910.

RESULTS OF ABOVE ANALYSIS FIGURED ON A BASIS OF 1 TON OF CANE TO THE SAMPLE.

No. of sample.	Nature of sample.	Weight of cane.	Weight of juice.	Loss of juice per ton due to borer.	Total solids per ton.	Loss in total solids due to borer.	Glucose per ton.	Increase glucose due to borer.	Solids not sugar per ton.	Increase in solids not sugar due to borer.	Sucrose per ton.	Loss in sucrose due to borer.	Actual loss in sucrose due to borer.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	P. ct.
1	Borer-free.....	2,000	1,222	.....	208.96	.....	19.55	.....	13.44	.....	175.97	.....	.....
2	Medium infested.....	2,000	1,216	6	195.77	13.19	20.67	1.12	14.59	1.15	160.51	15.46	8.78
3	Heavily infested.....	2,000	1,176	46	161.11	47.85	24.69	5.14	21.17	7.73	115.25	60.72	34.51

Experiment 3.—In order to confirm the results of the two foregoing experiments, and also to secure additional accurate data upon a larger scale, a third and larger experiment was conducted early in December, 1910. A wagonload of D. 74 cane was taken to the sugar house and was there divided into two lots, borer-infested and borer-free, the least sign of borer injury throwing a cane upon the infested pile. Of the 734 canes, 393, or 53.54 per cent, were infested. Each pile of canes was loaded separately upon a wagon and weighed on the platform scales. The 393 infested canes weighed 694 pounds,

an average of 1.76 pounds per cane, and the 341 borer-free canes weighed 626 pounds, an average of 1.84 pounds per cane. This gives an average loss in weight of 0.08 pound per cane. In 1 ton of cane like each of these samples there would be 1,087 borer-free canes and 1,136 borer-infested canes; or, in other words, it would require 49 more infested canes to make a ton than of borer-free canes. On a crop basis of 25 tons of uninfested cane per acre, this would show a loss of about 1 ton of cane per acre due to the borer.

Each lot of cane was then run through the mill separately and a sample of the juice taken. The 626 pounds of borer-free cane gave 431 pounds of juice, or 68.85 per cent extraction, while the 694 pounds of infested cane gave 455 pounds, or 65.56 per cent extraction. The loss of juice due to the borer was thus 3.29 per cent.

The two samples of juice were analyzed by Mr. W. G. Taggart, and showed a loss due to the borer of 1.5 per cent total solids, 2.1 per cent sucrose, and 5.6 per cent purity, with increases of 0.1 per cent glucose and 0.5 per cent solids not sugar. Figured on a basis of 1 ton of cane per sample, the losses are 66 pounds of juice, 30.69 pounds total solids, 36.57 pounds, or 19.33 per cent, sucrose, and increases of 0.72 pounds glucose and 5.17 pounds solids not sugar. The results of this analysis are shown in Table VII:

TABLE VII.—*Analysis of sugar cane (D. 74) to determine effect on sugar content of the borer injury to cane.*

Nature of sample.	Weight of cane.		Average weight per cane.		Loss in weight per cane due to borer.		Weight of juice.		Per cent of juice.		Loss of juice due to borer.		Total solids in juice.		Loss in total solids due to borer.		Glucose in juice.		Solids not sugar in juice.		Glucose ratio.		Sucrose in juice.		Loss in sucrose due to borer.		Purity.	
	Lbs.	Number of canes.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	
Borer-free.	626	341	1.84	.....	431	68.85	.....	16.7	.....	15.2	.....	1.5	.....	0.9	2.1	6.9	13.7	.....	82.0	.....	76.4	.....	5.6	.....	.....	.....	.....	
Infested...	694	393	1.76	.....	455	65.56	.....	3.29	.....	.....	.....	.....	.....	1.0	2.6	8.6	11.6	.....	.....	.....	.....	.....	.....	.....	.....	.....		

NOTE.—The above samples of cane constituted a wagon load which was taken to the sugar mill and there separated into infested and noninfested lots. There was no selection of canes in the field and the least borer injury served to throw a cane into the infested samples. December 13-14, 1910.

RESULTS OF ABOVE ANALYSIS FIGURED ON A BASIS OF 1 TON OF CANE TO THE SAMPLE.

Nature of sample.	Weight of cane.	Weight of juice.	Loss of juice due to borer.	Total solids.	Loss in total solids due to borer	Glucose.	Increase glucose due to borer.	Solids not sugar.	Increase solids not sugar due to borer.	Sucrose.	Loss in sucrose due to borer.	Per cent loss in sucrose due to borer.
Borer-free.	Lbs. 2,000	Lbs. 1,377	Lbs.	Lbs. 229.96	Lbs.	Lbs. 12.39	Lbs.	Lbs. 28.91	Lbs.	Lbs. 188.65	Lbs.	
Infested....	2,000	1,311	66	199.27	30.69	13.11	0.72	34.08	5.17	152.08	36.57	19.33

It should be noted as having a bearing on all of these analyses that the lower the purity of the juice the lower is the percentage of total sucrose that is recoverable in the form of sugar. Therefore the percentage loss of sugar in the impure samples somewhat exceeds the loss of sucrose. The sucrose which can not be recovered is approximately equal in amount to the glucose present. On this basis the present experiment would show a production of 176.26 pounds sugar per ton for the borer-free cane, while the borer-infested cane would give 138.97 pounds sugar, a loss of 37.29 pounds per ton of cane, equaling a loss of 21.16 per cent sugar, which is 1.83 per cent in excess of the sucrose loss.

It may be computed from the figures in Table VII that an acre of borer-free cane yielding 25 tons of cane of the above quality would yield 4,716.25 pounds sucrose per acre, while if it were infested to the same degree by borers, the yield under similar conditions would be 23.92 tons of cane and 3,637.75 pounds of sucrose per acre—a loss of 1,078.50 pounds sucrose per acre.

SUMMARY.

The sugar-cane borer damages cane in the field by destroying a considerable percentage of the eyes, thus reducing the stand of plant cane; by stunting the growth of the cane, owing to the physical injury of the stem; by admitting fungous diseases through the wounds in the stem; and is the main cause of injury by the wind, owing to the weakening of the stalk due to the tunnels and burrows. These classes of injury have been appreciated by planters. It now develops that there is another and very important class of injury which has been overlooked. This is the reduction of both the quantity and quality of the juice, which is dealt with specially in this circular. It becomes evident that both the planters and the manufacturers are vitally interested in the work of the sugar-cane borer. Investigations of methods of control in the field are now under way. The results will be published in due time. In the meantime planters are referred to the bulletin on the subject (Bulletin 70), by W. C. Stubbs and H. A. Morgan, of the Louisiana Experiment Station.

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